Doomed to isolation or just exploiting spatial benefits? Findings about the strange distribution of the Galapagos Shark [*Carcharhinus galapagensis*]

[Snodgrass & Heller, 1905]

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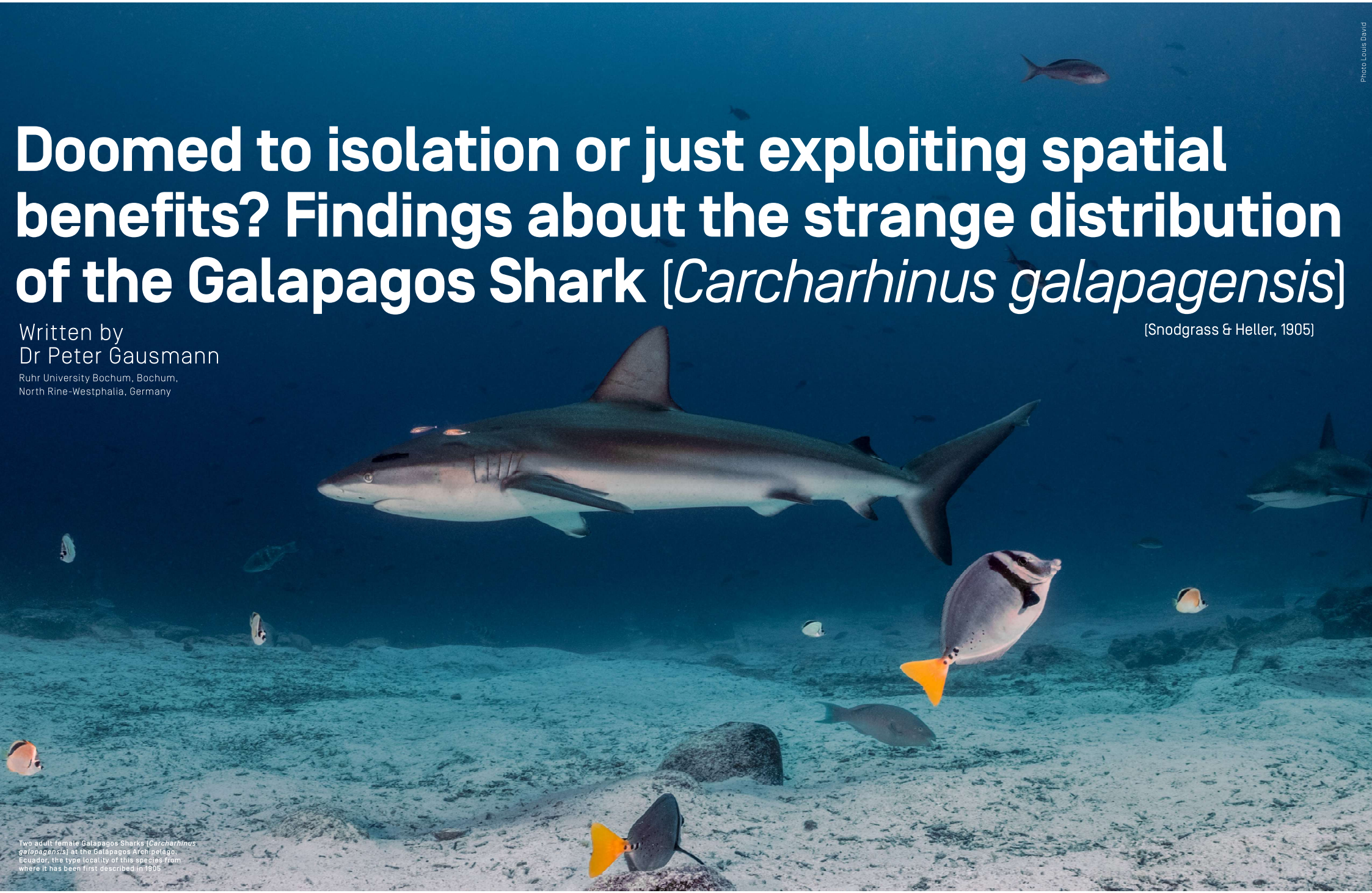

Photo Louis David

Two adult female Galapagos Sharks [*Carcharhinus galapagensis*] at the Galapagos Archipelago, Ecuador, the type locality of this species from where it has been first described in 1905

Introduction

The Galapagos Shark (*Carcharhinus galapagensis*) (Snodgrass & Heller, 1905) shows a cosmopolitan range that includes all three major ocean basins. Its distribution includes some of the most remote island ecosystems of the world such as Easter Island, Salas y Gómez, the Hawaiian Archipelago, Pitcairn Islands, Ascension Island, and St. Helena Island. This species is not well-studied, partly due to its core distribution around remote and isolated oceanic islands, archipelagos, atolls, and seamounts, mostly at great distances from continental coasts. This remoteness acts as a barrier to in-depth investigations due to the abandonment of these sites from scientific institutions. Its unusual distribution with an apparent preference for oceanic islands and atolls is poorly understood, adding this species to one of the many unresolved mysteries in the shark world. The Galapagos Shark has probably one of the most striking distribution patterns of all extant shark species. Since the 1960s, researchers have remarked on the curious preference of this species to occur only off the coasts of oceanic islands. Later, its strange distribution was characterized by other researchers as 'patchy', 'scattered', or 'disjunct'. Although the distribution of the Galapagos Shark includes all three major oceans, it has been reported only from a few atolls, archipelagos, islands, and seamounts yet. However, where it occurs, it can be the most abundant of local sharks. Due to its preference for such remote sites , in several locations it was discovered relatively late by scientists (e.g., St. Peter and St. Paul Archipelago: 1981; Azores Archipelago: 1988; Norfolk Island: 1993; Salas y Gómez Island: 2003; Mikomoto Island: 2015), stressing the need for ongoing research targeting this species.

Worldwide records and population structure

This unusual distribution pattern of the Galapagos Shark raised my interest because I am a geographer who is interested in the spatial distribution of sharks. Driven by curiosity, I tried to find a reasonable explanation for its strong attachment to remote, insular habitats. I conducted an extensive literature review with a holistic approach, accompanied with an investigation of public databases — as well as specimens housed in ichthyological collections — as well as additional sources for distributional data. I was able to identify 53 atolls and oceanic islands worldwide that harbor this species (and an additional 16 records from continental coasts), which is not much from a global point of view. Because the Galapagos Shark is a cosmopolitan species, my extensive literature review included a considerable number of non-English references. It has taken me six years to collate and analyze this widespread information to finish this study, which now possibly represents the most comprehensive species monograph that has ever been produced for a particular shark species. My investigation also included an analysis of the distribution of age classes at the sites where the Galapagos Shark has been verifiably recorded.

Thus, with only 53 verified occurrences at oceanic islands and atolls around the globe, the Galapagos Shark is a relatively rare, primarily insular species. However, the isolation of occurrences and the distance between their respective populations raises questions about the maintenance of gene flow and the spatial connectivity of subpopulations. Moreover, the limited number of occurrences makes this species susceptible to overfishing at its insular home ranges.

I found out that small juvenile Galapagos Sharks were exclusively recorded from oceanic islands, atolls, and seamounts, a great distance from continental coasts suggesting that birth of this species takes place in remote places and not in continental waters. As such, these remote and isolated offshore habitats likely represent nurseries and parturition sites.

Key findings and takeaways

1. With only 53 verified records around oceanic islands, atolls, and seamounts worldwide, the Galapagos Shark is a relatively rare species from a global perspective considering the entire number of islands in the tropics, subtropics, and warm-temperate regions of the world.
2. These oceanic island habitats provide likely nursery areas for this species, with small juvenile (i.e., neonates and young-of-the-year, YOY) Galapagos Sharks reported exclusively from oceanic islands, atolls, and seamounts, but never from continental coasts. This attachment of juveniles to remote island habitats can be understood as a reproductive strategy for this species to reduce mortality of the offspring. It is possible that this is because many larger sharks and ray predators such as Bull Shark (*Carcharhinus leucas*), Tiger Shark (*Galeocerdo cuvier*), and Great Hammerhead (*Sphyrna mokarran*) sharks are mainly distributed along the continental coasts and can be scarce, or lacking, in oceanic island habitats. As such, competition and predation can be considered range-building factors. Occasionally, subadult and adult Galapagos Shark venture to continental coasts where they are strays/roamers but do not build appear to have a resident population. Presumably, they do so when they have attained a size that allows for escaping large coastal sharks that feed on other sharks and rays.
3. Due to the relatively young evolutionary age of the Galapagos Shark (<1 million years ago) accompanied by a relatively young geological age of most of the oceanic islands and seamounts, these remote spots in the middle of the oceans may provide a wide array of free ecological niches that were occupied by marine fishes (including sharks) recently. As such, at some of these oceanic islands, the Galapagos Shark is one of the only known inshore sharks that occurs in rocky or coral reef and lagoon habitats (e.g., St. Peter and St. Paul Archipelago). Therefore, the occupation of free ecological niches available at remote oceanic islands may also explain the disjunct distribution pattern of the Galapagos Shark.
4. Because Galapagos Sharks are overwhelmingly residential with limited home ranges and show a strong affinity to specific sites (e.g., reefs and seamounts), they benefit greatly from spatial conservation approaches such as Marine Protected Areas (MPAs) and shark sanctuaries, especially those with accompanying no-take zones and fisheries regulations. However, it should be noted that illegal fishing of sharks still occur in some protected areas, thus affecting the Galapagos Shark, such as in the Galápagos Marine Reserve in Ecuador. Moreover, based on it limited distribution, it should be noted that the loss of a single local population at a specific island is likely to weaken the entire population of the respective ocean (sub)basin. This is because of the loss of a center of dispersal for Galapagos Sharks, and because islands and seamounts are also used as stepping stones for large-scale migrations that have been observed. There is evidence of a near extirpation of the local Galapagos Shark population around Brazil's St. Peter

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Galapagos Shark
(*Carcharhinus galapagensis*)

and St. Paul Archipelago in the equatorial Atlantic resulting from unsustainable fishing of sharks. Within Brazilian populations, there is significant concern for their survivability because this archipelago houses the only Brazilian population of this species. For other locations, data suggest that Galapagos Sharks have been seriously overfished and possibly no longer present, such as Walters Shoals, a group of submerged seamounts south off the coast of Madagascar, and one of only four localities in the Indian Ocean where this shark has been reported. However, its assessment on the IUCN Red List of Threatened Species as Least Concern seems to be justified since many populations of the Galapagos Shark are located in protected areas (e.g., Ascension Island Marine Protected Area, Kermadec Island Marine Reserve, and Lord Howe Island Marine Park) nowadays. Nevertheless, several other oceanic islands and archipelagos with Galapagos Shark occurrences are largely unprotected, or fishing is intense despite administrative protection ('paper parks'). This applies, for example, to Brazil´s St. Peter and St. Paul Archipelago that, although it has been declared a protected area (Marine Natural Monument), fisheries still operate in those waters. Due to its remoteness, it is virtually unmonitored, and fishing activities continue.

5. The Galapagos Shark can be difficult to identify, due to its similar appearance to several other requiem sharks (*Carcharhinus* spp.) such as the Grey Reef Shark (*C. amblyrhynchos*) and the Caribbean Reef Shark (*C. perezi*) as well as their ancestor, the Dusky Shark (*C. obscurus*) . As such, misidentifications occurs frequently and the number of unconfirmed records of this species is likely high. Therefore, reports of the Galapagos Shark based on visual observations only should always be treated with caution.
6. The situation of the Galapagos Shark has been investigated the most in the Eastern Tropical Pacific (ETP) as well as in the Southwestern Pacific Ocean where topics such as genetics, population structure, and migration behavior have been studied in depth. There is also knowledge about the biology of the Galapagos Shark around the Hawaiian Islands. However, there are remaining huge areas with data deficiencies such as the Western Indian Ocean and the Atlantic Ocean, where information on biology and ecology is scarce or lacking, and only a few investigations have been conducted. For example, in the North Atlantic Ocean, juvenile Galapagos Sharks were once reported occurring at the Azores Archipelago in the middle of the 1990s. However, since then, no further studies targeting this species have been conducted Thus, nothing is known about the status the Galapagos Shark around the Azores and other Macaronesia islands (Madeira, Canary Islands) with the exception that it has been verifiably recorded from here. These data gaps still provi a barrier to successful and effective conservation strategies and management plans for this species.
7. Some aspects of the distribution of the Galapagos Shark remains a conundrum and are still unresolved, such as the lar distribution gap between the Western Indian Ocean and the Western Pacific Ocean. Therefore, attention should be paid to possible occurrences of this species in the Central and Easter Indian Ocean to close remaining knowledge and distribution gaps.

Acknowledgements

I deeply acknowledge the numerous shark scientists from all around the world who provided information or access to hard-to-access literature that helped me with the completion of my review as well as Kaitlyn McQueeney, Camila Brasilino Botêlho de Araújo, and Louis David for their permission to use photographic material.

All the results cited above can be found in more detail in this forthcoming publication

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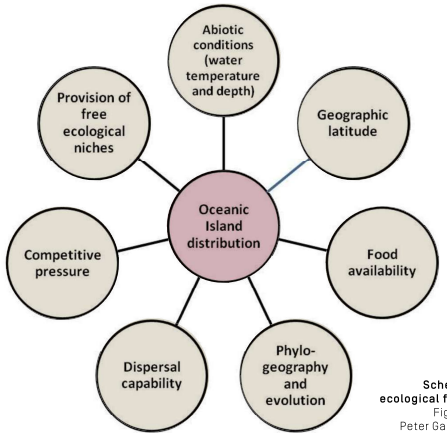

Scheme of ecological factors
Figure by
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Distribution map
Maps by
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